MONITORING PLAN

PROJECT NO. MR-06 CHANNEL ARMOR GAP CREVASSE

ORIGINAL DATE: November 22, 1996
REVISED DATE: July 23, 1998

Preface

Pursuant to a CWPPRA Task Force decision on April 14, 1998, the original monitoring plan was reduced in scope due to budgetary constraints. Specifically, discharge and suspended sediment sampling was reduced by 50%.

Project Description

The proposed project area is located in the Mississippi River Delta, south of Venice in Plaquemines Parish, Louisiana (figure 1). The crevasse will be constructed on the left descending bank of the main river channel, at river mile 4.7 above Head of Passes. The project outfall area, Mary Bowers Pond, is located adjacent to the Mississippi River channel and Main Pass, within the boundary of the Delta National Wildlife Refuge. The project area is comprised of 30% freshwater marsh and 70% shallow, open water, totaling 2,097 ac (849 ha).

The Mississippi River Delta is the seventh in a sequence of eight major delta lobe complexes formed by the Mississippi River within the past 7,500 years, and it is situated between two formerly active delta lobes: St. Bernard to the east and Lafourche to the west (Frazier 1967). Formation of the Mississippi River Delta initiated approximately 400 years ago through channel switching and bifurcation processes that resulted in several small overlapping lobes (subdeltas) within the delta. The natural tendency is for the Mississippi River to now enter the abandonment phase of the transgressive deltaic cycle. This abandonment would cause the current delta to erode into a barrier island system (figure 2) and form a new active delta via the Atchafalaya River, a more efficient route (Fisk 1952). However, the delta-switching process has been prevented by artificial levees constructed in 1927 and the extensive rock reinforcement of those levees throughout the past few decades.

It is hypothesized that human alterations to the Mississippi River have caused negative consequences for the hydrologic cycle of the Mississippi River and its wetland-building processes. Firstly, prolonged maintenance of the river in its present location through artificial levees has caused rapid sedimentation onto the continental shelf and seaward progradation of the river mouth at rates up to 100 m/yr within the past several decades. This rapid sediment deposition, coupled with gas formation (production of methane gas through bacterial decomposition of abundant organic matter) and wave loading (conversion of dissolved gases to bubble phase gases, e.g., methane, carbon dioxide, sulfide), has created an extremely unstable delta front. Instabilities at the continental shelf edge have induced the removal of large volumes of sediment from the delta front onto the continental slope or basin floor through rotational and retrogressive slides (Coleman et al. 1983).

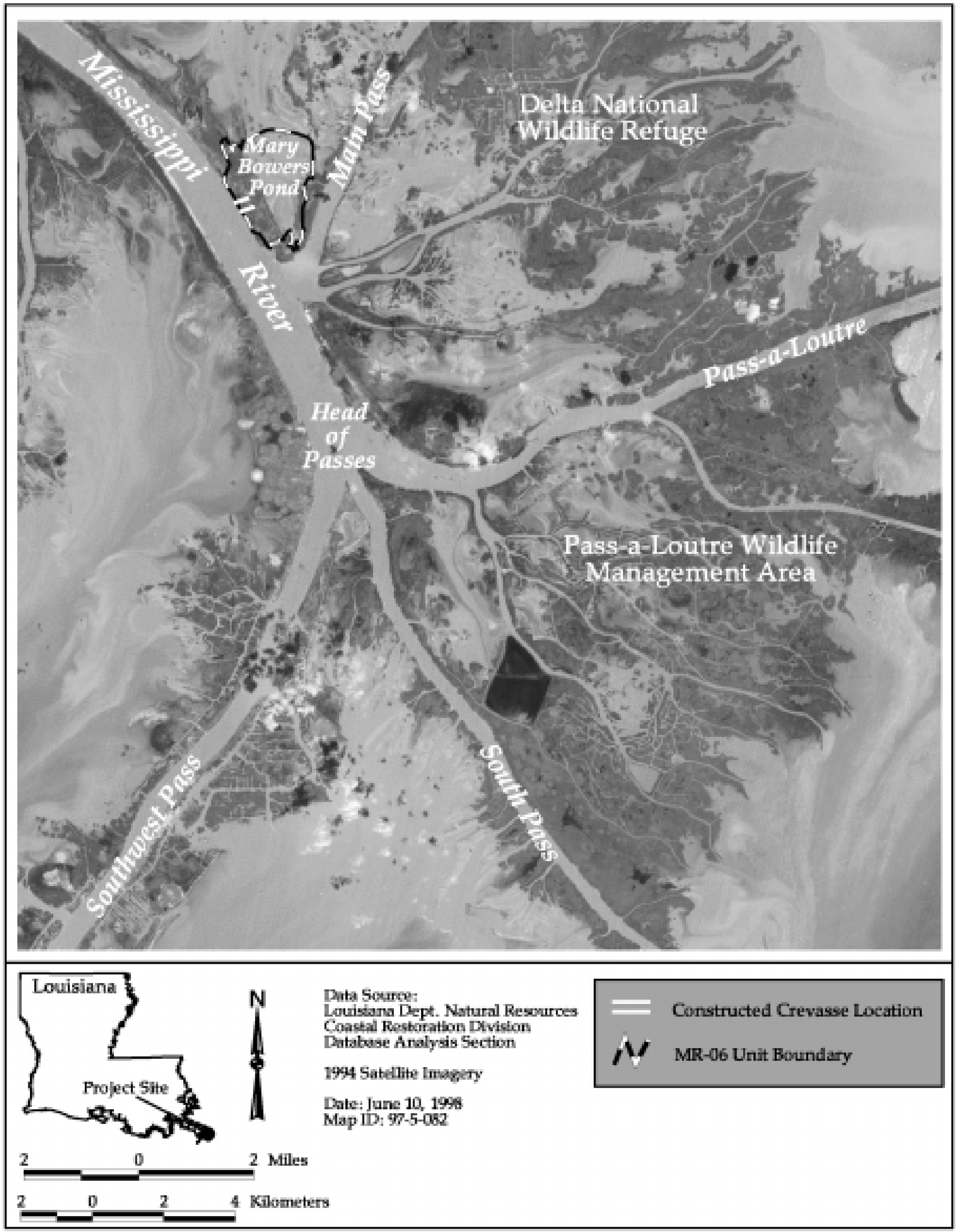

Figure 1. Channel Armor Gap Crevasse (MR-06) project location.

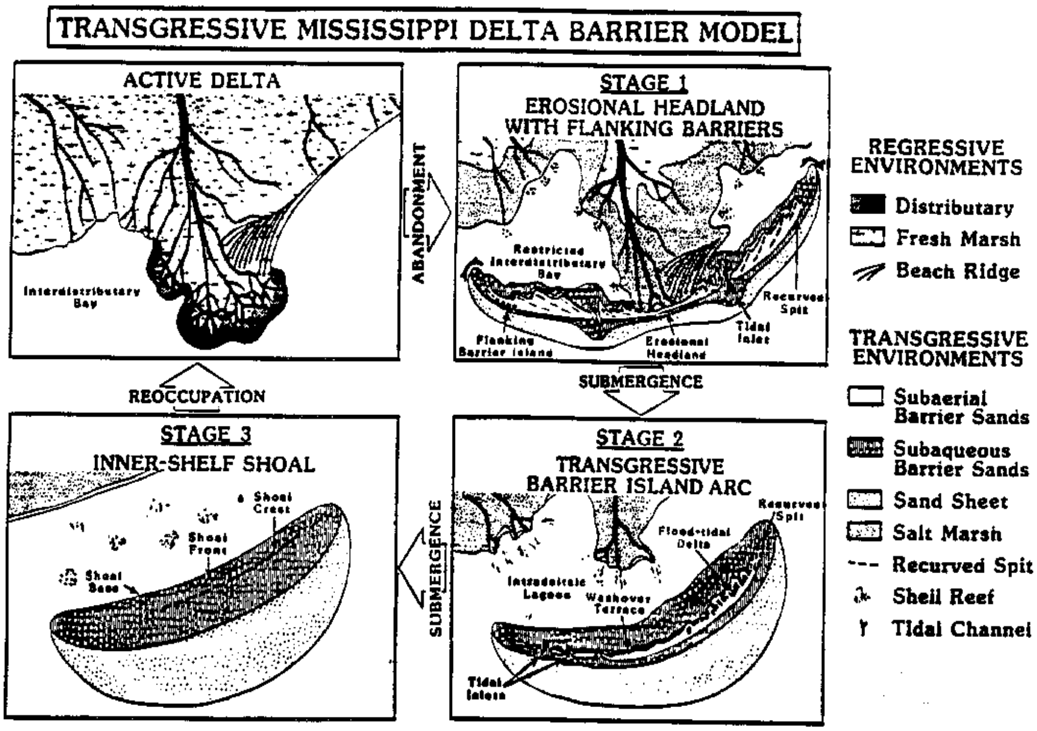

Figure 2. The genesis and evolution of transgressive depositional systems in the Mississippi River delta plain (Penland et al 1988).

Secondly, an abundance of small, bifurcating distributaries throughout the delta has caused a loss in the stream gradient that is critical to efficient sediment delivery. Growth of the delta has therefore not been limited by the size of the receiving basin, but by inefficient sediment delivery. Research shows that the Mississippi River currently delivers 50 to 60 percent less sediment to the Gulf of Mexico than it did in the early 1900s (Wells and Coleman 1987). Much of this sediment loss has been due to trapping of coarse sediment material, which is essential in building subaerial land, by upstream engineering structures such as dams and reservoirs in the Arkansas, Missouri, and Ohio river basins.

Rapid wetland deterioration in the Mississippi River Delta is likely due to a combination of the above factors, instabilities at the delta front causing massive sediment loss and inefficiency in sediment delivery, in conjunction with eustatic sea level rise. The subsidence rate for the entire delta is approximately 0.45 in/yr (1.1 cm/yr) (Day and Templet 1989) as evidenced by the several hundred hectares of shallow water ponds that have replaced former freshwater marshes (White 1993). Subsidence rates are further exacerbated by frequent canal dredging for navigation purposes and by fluid and gas withdrawals for mineral resources mining. The most recent land loss rate estimate for the Mississippi River Delta is 5.37 mi^2/yr (13.91 km^2/yr), which is 21% of the total annual land loss occurring in the Louisiana coastal zone (Dunbar et al. 1992).

When the Mississippi River levees were reinforced with stone, some shallow gaps were left in the river bank armor to allow overflow of freshwater and naturally occurring levee breaches (crevasses) during periods of high river stages. Crevasses promote infilling of shallow interdistributary ponds with sediment-laden river water and eventually create subaerial land (or deltaic splays) that becomes colonized with marsh vegetation (figure 3). A naturally occurring crevasse splay typically has a life cycle ranging from 20 to 175 years, depending on the size of the crevasse and adjacent parent pass, water discharge, sediment volume, and wind and tidal influences (Wells and Coleman 1987). Between 1750 and 1927, regularly occurring crevasse splays were responsible for building more than 80% of the Mississippi River Delta wetlands (Davis 1993).

Since the early 1980s, the method of artificially creating crevasses has been used as a management tool for combating wetland loss in the Mississippi River Delta. This technique is recognized as both cost-effective and highly successful at creating new wetlands. Artificial crevasse construction is an attempt to mimic natural crevasse formation processes. Wells and Coleman (1987) found that artificial crevasses at Cubits Gap, West Bay, and Garden Island Bay subdeltas enhanced the processes of natural crevasse splay formation through breaching of the levee system and allowing sediment infilling. The Louisiana Department of Natural Resources (LDNR) constructed three crevasses in 1986 (on Pass-a-Loutre, South Pass, and Loomis Pass) that produced over 657 ac (266 ha) of emergent marsh from 1986 to 1991, and four crevasses in 1990 (two each on South Pass and Pass-a-Loutre) that produced over 400 ac (162 ha) of emergent marsh from 1990 to 1993 (LDNR 1993; Trepagnier 1994). The average cost per crevasse in 1990 was approximately $48,800, which translates into $433/acre of wetland created for this particular project. Boyer et al. (1996) report that the average cost per area of land gain for 24 constructed crevasses in Delta National Wildlife Refuge declines with age as new land builds and has the potential to equal $19 per acre if all the open water ay fills in. Thirteen crevasses included in the LDNR Small Sediment Diversionsproject (MR-01)

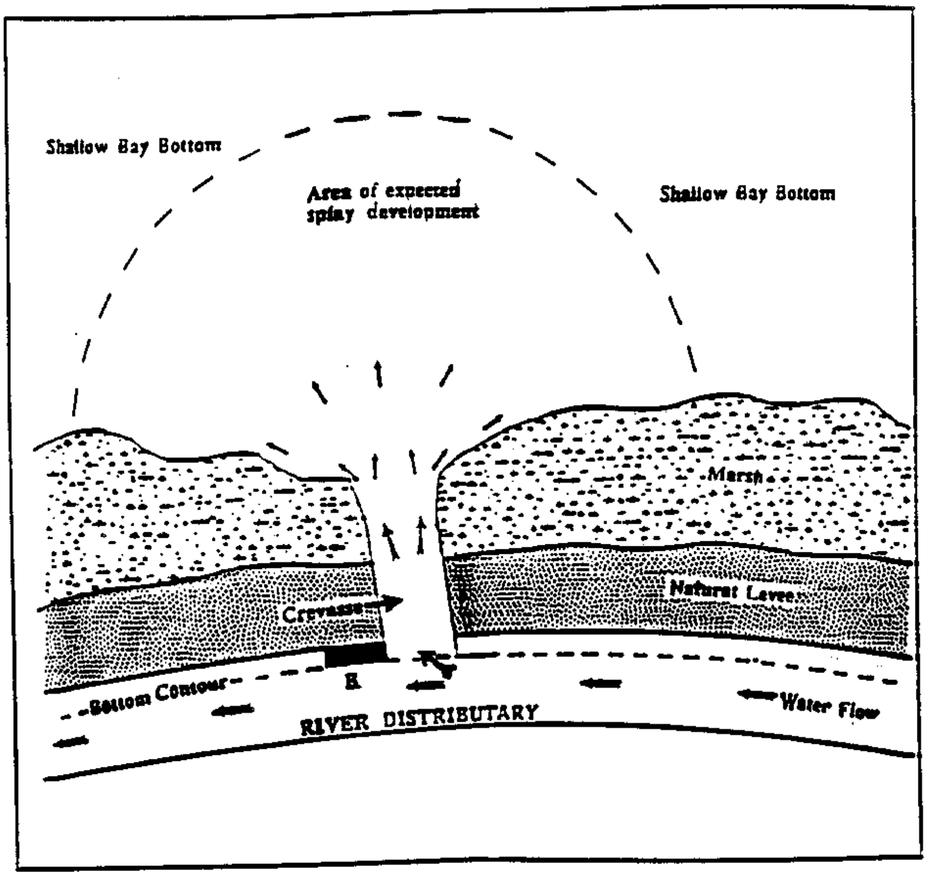

Figure 3. Schematic diagram of the artificial crevasse splay construction through a controlled breach of a distributary channel levee.

in the receiving bay fills in. Thirteen crevasses included in the LDNR Small Sediment Diversions cumulatively produced 313 ac (127 ha) of emergent marsh between 1986 and 1993; land growth rates ranged from 28 to 103 ac (11.3 to 41.7 ha) per crevasse for the older crevasses (4 to 10 years old) and 0.5 to 12 ac (0.2 to 4.9 ha) for the younger crevasses (0 to 2 years old) (LDNR 1996).

The general patterns of plant community colonization and succession have been well-documented on both naturally and artificially created crevasse splays in the Mississippi River Delta. White (1993) delineates vegetation that colonizes newly emergent deltaic mudflats into three major plant communities: (1) forests of *Salix nigra* (black willow) establishing on upstream, high elevation islands that usually consist of the coarsest sediments, (2) stands of *Scirpus deltarum* (delta three-square) that develop downstream from the forested islands at intermediate elevations (between 10 cm and sea level), and (3) communities of *Colocasia esculenta* (elephant ear) developing just downstream from the forested islands, where the finest sediments are deposited and land elevation is below MSL.

While the *S. nigra* and *C. esculenta* communities develop rapidly and are usually prolific by the end of the first post-emergent growing season, the delta three-square communities typically do not become dominant until the third growing season. During the first two growing seasons, these intermediate-elevation mudflats are colonized by several annual and perennial herbs. During the six years of his study, White (1993) identified 62 plant species from 21 families on the deltaic splays, with grasses and sedges being the most common.

The dominant soil series currently found within the MR-06 project area is Larose. Larose soils are described as continuously flooded, deep, very poorly drained and very slowly permeable mineral clays and mucky clays. They are distributed on the fringes of freshwater marshes, adjacent to the natural distributary levees of the Mississippi River, at an elevation less than 3 ft (0.9 m) and slope less than one percent. Since Larose soils are deposited underwater, never being air-dried or consolidated, they remain semifluid and highly unstable (Natural Resources Conservation Service n.d.).

The objective of this project is to promote the formation of emergent freshwater marsh in place of the shallow, open-water area of Mary Bowers Pond. This objective will be met by enlarging an existing gap in the Mississippi River levee to allow an increased flow of sediment-laden river water into the receiving bay. The result will be the conversion of an area of 60% open water to an area of approximately 90% emergent wetland. Over the 20-yr life of the project, this crevasse is expected to create approximately 1,000 ac (405 ha) of emergent marsh.

The project features include:

1. Excavating a crevasse channel that will directly connect the Mississippi River and Mary Bowers Pond. The existing gap in the Mississippi River channel bank armor will be enlarged to a length of 3,400 ft (1,036 m), a bottom width of 80 ft (24 m), a top width of 130 ft (40 m), and a minimum depth of -4.0 ft (-1.2 m) NGVD. The crevasse channel will allow an average flow of 2,400 cfs (68 cms) to enter the outfall

area. Approximately 70,000 yd^3 (53,522 m^3) of material will be excavated from the outfall channel. The dredged material will be deposited in a non-continuous fashion adjacent to the channel, with a minimum of four 50-ft (15.2 m) wide gaps, and at an elevation not to exceed +4.0 ft (1.2 m) above existing surface elevations.

Project Objective

1. Create emergent freshwater wetland habitats typical to the area in a shallow, open-water pond by diverting sediment-laden water from the Mississippi River.

Specific Goals

The following goals will contribute to the evaluation of the above objective:

1. Create an efficient crevasse channel by enlarging an existing gap in the Mississippi River bank.

2. Increase mean elevation within the receiving bay, Mary Bowers Pond.

3. Increase the mean percent cover of emergent wetland vegetation in the receiving bay.

Reference Area

A formal reference area was not selected for this project, following the justification set forth in Steyer et al. (1995). It has become common practice within the last 10 years for the two refuge landowner agencies (USFWS and LDWF) to construct crevasses throughout the delta. Presently, Delta National Wildlife Refuge has approximately 25 constructed crevasses and Pass-a-Loutre Wildlife Management Area has approximately 20 constructed crevasses. Both agencies have communicated a strong potential for additional crevasses to be constructed in the near future. The extent of future wetland alterations in the delta is therefore unknown and could likely result in the loss of a reference area before monitoring for MR-06 is completed. As an informal reference, aerial photography taken throughout the entire Mississippi River delta will be utilized to evaluate temporal changes in open-water areas that have not been influenced by crevasse splays. Additionally, results from other sediment diversion projects (e.g. Small Sediment Diversions, MR-01) will serve for comparison and aid in evaluating the effectiveness of MR-06. Statistical tests will be based on time series data from a one-time as-built or pre-construction monitoring sample and several post-construction monitoring sample dates.

Monitoring Elements

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

1. Habitat Mapping — To document the expression of subaerial land and vegetated and non-vegetated areas, near-vertical, color-infrared aerial photography (1:12,000 scale) will be obtained. The photography will be georectified, photo interpreted, and analyzed with GIS by National Wetlands Research Center (NWRC) following procedures outlined in Steyer et al. (1995). Photography will be obtained at the earliest possible time between July 1 and September 1, for the following years: pre-construction, and 2000, 2007, and 2016 post-construction. Additional photography may be obtained in response to storm or major flood events. Photo interpretations will be ground-truthed by LDNR personnel.

2. Elevation — To document changes in mean elevation within the project area related to the creation of subaerial land, elevational transect lines will be established across the entire project area (figure 4). Benchmarks will be installed at the time of construction at the Mississippi River levee and tied to NGVD using an established benchmark located at the USFWS Wildlife Headquarters lookout tower, north of Cubits Gap. Eleven elevational transect lines and one baseline which includes at least two benchmarks will be established perpendicular to the crevasse channel, spaced 500 ft (152 m) apart, and run the entire length of open water areas in the receiving bay. Elevations will be recorded at 500-ft intervals along each transect and at any significant change in elevation within those intervals. Elevational surveys will also include a cross-sectional profile of the crevasse channel, with data recorded every 10 ft (3 m) across the channel. Elevation surveys will be conducted as-built and during years 2000, and 2007 post-construction.

3. Vegetation — Plant species composition, percent cover, and relative abundance will be evaluated to document vegetation succession on the newly created crevasse splay and to ground-truth aerial photograph interpretations. Vegetation surveys will follow the Braun-Blanquet method as described in Steyer et al. (1995). Data will be collected at the same sample stations established for elevation measurements whenever possible. Transects will be established once the splay islands become subaerial, at locations where all major plant communities will be intersected.

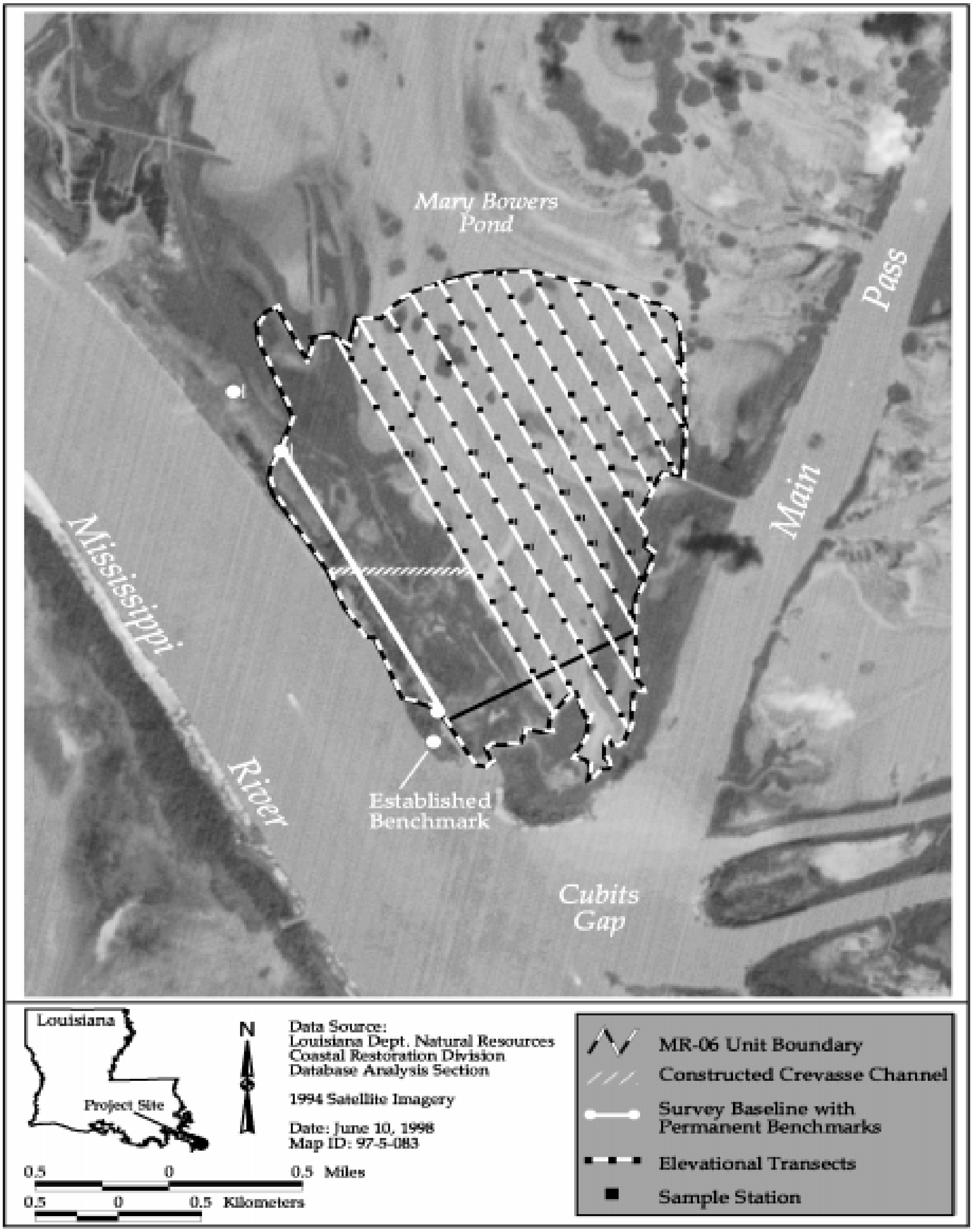

Figure 4. Schematic diagram of elevational transects and sampling stations in the MR-06 project area.

Sample stations along each transect will be established to represent the major plant communities of interest (*S. nigra*, *S. deltarum*, mixed marsh, pioneer marsh, and *Sagittaria* spp.), with at least five plots in each community. Additional transects and sample stations will be established over time as new land is created. Vegetation samples will be conducted in the late summer (mid-July to August) of the post-construction years designated for aerial photography, years 2000, 2007, and 2016.

4. Water Discharge

Water velocity in the crevasse channel will be measured regularly to monitor changes in flow over time. Velocity measurements will be taken with a hand-held velocity meter at five even intervals across the crevasse channel and depth-integrated to establish a ratings curve. Data will be collected immediately after construction, once per month during the first post-construction year (1998), and twice per year during high and low river stages (spring and fall) for 1999-2003, 2007, and 2016. In 2003, the TAG will assist the CRD monitoring manager with evaluation of the data and determination of whether additional water discharge data is necessary during the remainder of the 20-year project life. Water discharge data will be compared to suspended sediment concentrations to determine the relationship between the two elements. Seasonal variations in water discharge will also be compared to the amount of sediment deposited in the project area.

5. Suspended Sediment

Suspended sediment concentration will be measured in conjunction with water discharge to determine the relationships of sediment load with water flow through the crevasse channel and sediment deposited in the project area. Measurements will be taken with a point sampler at five even intervals across the crevasse channel and at five depths along a vertical profile for each sample location. All available suspended sediment data collected from Head of Passes will be used in comparing the relative sediment loads of the Mississippi River and the crevasse channel. Sample dates will coincide with those for water discharge. Data will be collected immediately after construction, once per month during the first post-construction year (1998), and twice per year during high and low river stages (spring and fall) for 1999-2003, 2007, and 2016. In 2003, the TAG will assist the CRD monitoring manager with evaluation of the data and determination of whether additional suspended sediment data is necessary during the remainder of the 20-year project life.

Anticipated Statistical Tests and Hypotheses

The following hypotheses correspond with the monitoring elements and will be used to evaluate the accomplishment of the project goals.

1. Descriptive and summary statistics will be used on historical data and habitat mapping data collected during post-project implementation to assess changes in marsh loss/gain rates over time and to assess whether the post-project marsh loss rate deviates from the expected "future without project" conditions. Acreage of new marsh created as a result of the project will be documented over time and growth rates of the crevasse splay will be compared to those of other previously constructed artificial crevasse splays. Vegetated marsh:open water ratios will also be calculated and documented over time.

2. Elevational data will be evaluated through paired t-tests or analyses of variance (ANOVA's). These tests will allow for the analysis and documentation of elevational changes in the project area over time.

   Goal: Increase mean elevation of the receiving pond.

   Hypothesis:

   H_0: Elevation in project area at time i will not be significantly greater than elevation before project implementation.

   H_a: Elevation in project area at time i will be significantly greater than elevation before project implementation.

3. Vegetation data will be evaluated through paired t-tests or ANOVA's. These tests will allow for the analysis and documentation of vegetation changes within the project area over time.

   Goal: Increase the mean percent cover of wetland vegetation in the receiving pond.

   Hypothesis:

   H_0: Vegetative cover in receiving bay at time i will not be significantly greater than vegetative cover before project implementation.

   H_a: Vegetative cover in receiving bay at time i will be significantly greater than vegetative cover before project implementation.

4, 5. Regression analysis will be performed on water discharge and suspended sediment data to determine if any correlations exist between water flow and sediment load in the crevasse channel with respect to seasonal variations. Descriptive and summary statistics will be used to compare these data to subaerial land calculations in the project area and seasonal variations in water flow and sediment load for the Mississippi River. Analysis of these two monitoring variables will be contingent upon an agreement to monitor by USACE.

Goal: Determine the correlation factor between water discharge and suspended sediment flow through the crevasse channel over time.

Hypothesis:

H_0: Water discharge will not be correlated to suspended sediment load.

H_a: Water discharge will be correlated to suspended sediment load.

If we fail to reject any of the null hypotheses, all possible negative effects will be investigated.

NOTE: Available ecological data, both descriptive and quantitative, will be evaluated in concert with all of the above data and with statistical analyses to aid in determination of the overall project success.

Notes

1.	Implementation:	Start Construction: End Construction:	September 15, 1997 December 15, 1997
2.	USACE Point of Contact:	Richard Boe	(504) 862-1505
3.	DNR Project Manager: DNR Monitoring Manager: DNR DAS Assistant:	Gus Cretini John Troutman Brian Zielinski	(504) 342-6814 (504) 342-1952 (504) 342-4123

4. The twenty year monitoring plan development and implementation budget for this project is $393,778. A progress report will be available in December 1999, and comprehensive reports will be available in December 2001, December 2004, December 2008, and December 2017. These reports will describe the status and effectiveness of the project.

5. Near-vertical color-infrared aerial photographs of the project area were taken on the following dates: 11/83, 12/85, 12/90 (1:62,500 scale); and 11/93 and 1/96 (1:12,000 scale). The 1/96 aerial photographs, which were previously obtained by LDNR for State purposes and encompass the entire Mississippi River Delta, will be used by NWRC as the preconstruction set of photographs for habitat mapping of MR-06.

6. Locations of transect sampling may change pending pre- and first post-construction elevational surveys tracking splay formation.

7. Ancillary data on submerged aquatic vegetation (species composition and abundance lists) will be provided at each vegetation sampling time.

8. After 10 years of data has been collected, the TAG will assist the CRD monitoring manager in evaluation of the elevational, water discharge, and suspended sediment data with respect to achieving the project goals and objectives. A determination will then be made on whether it is necessary to collect additional data for these monitoring elements during the remainder of the 20-year project life, and if so, whether to conduct monitoring on a regular basis or on a event-driven basis (i.e. during/after major storms, flood events). If additional data collection is deemed necessary, the USACE and CRD project managers will solicit the Task Force for additional funding.

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